

Temporal noise shaping, quantization and coding methods in perceptual audio coding: A tutorial introduction.

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Temporal Noise Shaping, Quantization and Coding Methods in Perceptual Audio Coding: A Tutorial Introduction

The first part of this tutorial features an introduction to the Temporal Noise Shaping (TNS) approach, including its background, time-frequency interpretation, and interaction with the filter bank. The second part addresses the issues of quantization, noiseless coding, and combined methods used in perceptual audio coders. Both variable and constant-rate coding scenarios will be discussed.

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TEMPORAL NOISE SHAPING, QUANTIZATION AND CODING METHODS IN PERCEPTUAL AUDIO CODING: A TUTORIAL INTRODUCTION

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Perceptual audio coding has become an important key technology for many types of multimedia services these days. This paper provides a brief tutorial introduction into a number of issues in today's low bitrate audio coders. After discussing the Temporal Noise Shaping technology in the first part of this paper, the second part will focus on the large number of possible choices for the quantization and coding methods for perceptual audio coding along with examples of real-world systems using these approaches.

INTRODUCTION

Perceptual audio coding has become an important key technology for many types of multimedia services including audio playback and storage.



Figure 1. Generic structure of a perceptual audio encoder (coder) and decoder (decoder).

Generally, the well-known generic structure of a perceptual audio coder for monophonic audio signals can be described in the following way (see Figure 1):

- The input samples are sampled into a sub-sampled spectral representation using an analysis filterbank.
- Using a perceptual model the signal's frequency and time dependent masking threshold is estimated. This gives the maximum coding error that can be introduced into the audio signal while still maintaining perceptually transparent signal quality.
- The spectral values are then quantized and coded according to requirements defined from the masking threshold estimate. In this way, the quantization noise is hidden ("masked") by the respective transmitted signal as far as possible and perceptibility of the coding error is minimized.

- Finally, all relevant information (i.e. coded spectral values and additional side information) is packed into a bitstream and transmitted to the decoder.

Accordingly, the order of processing appears reversed in the corresponding decoder:

- The bitstream is decoded and parsed into coded spectral data and side information.
- The inverse quantization of the quantized spectral values is carried out.
- The spectral values are mapped back into a time domain representation using a synthesis filterbank.

This paper provides a tutorial overview over certain aspects of perceptual audio coding and is structured as follows. The first part of the paper will address the general issue of the temporal masking problem in perceptual audio coding and describe the so-called Temporal Noise Shaping (TNS) technology. In particular, the principle and theoretical background of the TNS approach is discussed along with its integration into a perceptual sub-coder.

In the second part of the paper, the fundamental issues of quantization and coding in a perceptual audio coder are considered and the most important technical approaches are contrasted. Examples will be given for the use of the discussed techniques in standardized or industry standard coders. Finally, a discussion of encoding strategies will conclude the paper.

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